

# Digital Speech Therapist: An Android Application for Speech Articulation Problems in Children

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**Abstract**—Humans are affected by speech articulation difficulties for a variety of reasons, including genetics, deficiencies, traumas, and biological issues. Children, especially those in their formative years, are especially vulnerable since they learn through communication, and if they are unable to communicate well, they may lose confidence, resulting in a long-term communication gap with others. This research helps these children, by the Speech Rectification Application. This was planned to use it to help those who were employing strong algorithms like Google's BERT. In this study, researchers were able to train the system using a variety of techniques, including language modeling, tokenization, prediction, and more. In this study, we were able to train the system using a variety of techniques, including language modeling, tokenization, prediction, and more. The software has a number of features that help children learn and improve, as well as real-time support. Correction of speech-to-text, speech-to-text, and text-to-speech (to learn new languages)

I. INTRODUCTION People tend to focus on speech loss and articulation problems in speech-impaired children. Voice difficulties, such as irregular tone, loudness, and sound quality, are prevalent issues in children with speech articulation and loss, according to the clinic. Speech impaired children's voices sound varies depending on their level of voice disorders, and their speech intelligibility suffers as a result. Many children's speech and language development will be delayed for a while. The great majority

of people will catch up eventually. Others will have a difficult time improving their communication abilities. Speech and language disorders are two types of communication impairments.

**Disorders in speech:** A cleft palate, dental difficulties, hearing loss, or difficulty regulating mouth motions can all produce speech sound abnormalities.

*Concerning Factors*

- By the age of 8 or 9 months, the kid has stops babble with consonant alphabets
- The kid usually communicates using vowel sounds or gestures after 18 months of age.
- At the age of three, many adults are unable to understand the child's speech.
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- Children's speech is difficult to understand at age of 4 years.

**Disorders of the Voice:** Voice issues can be caused by cysts, nodules, paralysis, papillomas, and weakening of the vocal folds.

**Resonance disorder:** These disorders can be the following:

**Hyponasality (Denasality):** When a child's nose does not receive enough sound, he or she sounds "stopped up." An obstruction in the nose or allergies could be to blame.

**Hypernasality:** Hypernasality occurs when the movable, soft portion of the palate (the velum) does not completely seal the nose from the back of the throat during speaking. As a result, a significant amount of sound is lost via the nose. A cleft palate, a submucous cleft, a short palate, a large nasopharynx, too much tissue removed following an adenoidectomy, or inadequate soft palate mobility can all contribute to this condition.

**Cul-de-Sac:** Resonance occurs when there is a barrier of sound in the nose, mouth, or throat. As a result, the speaker's voice is muffled or silenced.

#### *Concerning Factors*

The nature of speech might be hyponasal or hypernasal. Air can be heard coming out of the nose when speaking.

Disorders in fluency: The speaker's and other listeners' internal and outward emotions may have an influence on fluency, but they do not cause it.

#### *Concerning Factors*

- Nurtures are worried about stammering in their children.
- The youngster is tense throughout his speaking.
- The youngster avoids speaking because he or she is afraid of stuttering.

The youngster imagines himself to be a stutterer. Exchange of ideas is a multifaceted, dynamic process that allows people to convey their ideas, feelings, and desires. Communication becomes disordered when one or more functions involved in the communication process are disrupted. A communication problem has a significant influence on the quality of our everyday lives. People experience challenges in their life because of communication issues that can include:

- **Social difficulty:** Communication problems may affect your relationships with family and friends and make social situations challenging.
- **Depression:** In some people, it may lead to social isolation and depression.
- **Psychological impact:** Person affected with speech disorders face severe embarrassment, teasing, bullying at school and workplace which leads to poor confidence and lack of self-esteem.
- **Anxiety Disorders:** Speech disorders may result in serious anxiety disorders like phobia of public speaking etc.

- **Learning Disorder-** Since speech is necessary for communication it can lead to learning disorders affecting career, future, and relationships.

It reduces the capacity to express personality. Therefore, it is important to enhance the communication quality of individuals suffering from a verbal communication disability by offering them more possibilities to interact with their environment.

In recent years, computer software has been increasingly used in the context of speech disorders. Researchers have explored the idea that artificial intelligence (AI) could be used to diagnose speech disorder that helps people to improve social, communication, and emotional skills. Artificial Intelligence and Machine Learning developed the algorithms and devices that compensate for communicative and cognitive impairments. Today, AI-based apps are less costly and easier to integrate into ordinary homes, schools, and therapists' offices than high-end robots.

**Helping Your Child:** Listening to people talk and practicing while speaking with them helps children develop speech and language skills. Parents are their children's first and most important instructors. They can help the child by giving him or her several opportunities to listen and talk with them. This may be performed by regularly discussing and pointing out important persons, places, and things. They can read to the kid at any time during the day, especially during daily routines, play interactive games, and enjoy most activities. For their children to repeat, parents might give them samples of words and sentences. Allowing children to debate and reply to questions is also an option for parents. Listening to music, singing songs, and sharing nursery rhymes with your kid are all enjoyable activities to help your child develop his or her speech and language skills. People tend to focus on speech loss and articulation problems in speech-impaired youngsters. Voice difficulties, such as inappropriate tone, loudness, and sound quality, are prevalent issues in children with a speech impediment, according to the Clinic. Hearing-impaired children's voices sound varies depending on the severity of voice disorders, which also affects their speech intelligibility. We outline the associated domestic and international research on speech-impaired children's voice characteristics and voice correction in this article to give guidance and a foundation for future study on speech-impaired children's voices.

"Our intelligence is what makes us human, and Artificial Intelligence is the extension of that quality." Yann LeCun Artificial Intelligence solves almost all the modern world problems. We must use it to the best of our efforts. An articulation Speech disorder is a very common problem among people. It can be treated through speech therapy but if people need immediate assistance or most people don't go

for such therapies for their children due to various factors. For years, people have tried to break down communication barriers for those with speech disorders by developing new speech technologies. There are a lot of people with speech disorders. In recent times, people with speech disorders are found to be facing serious discrimination within society at schools, public places, and even within their families too. Therefore, in this article, an attempt is made to develop an application to help people suffering from speech disorders and to provide people the confidence to speak accurately and bridge the gap of communication with peers. So, they can participate in different activities effectively. This application will improve techniques taught in speech therapy.

## II. RELATED WORK

There are several applications on the market to identify speech issues and promote behavioral treatment and learning, but most of them are quite straightforward logical tools for obeying a set of rules and collecting points. There are various job-hunting apps accessible.

**Speech Therapy App:** This app is for people who have trouble speaking or hearing. It's an excellent approach to work on the sounds that the Speech Therapist has recommended. The software is jam-packed with captivating images, entertaining activities, and amusing games. This promotes the practice and leads to improved speech improvement. The interface of the application is shown in Figure 1.



Figure 1. The interface of Speech Therapy Application

**Speech-to-Text App:** A simple to use app for dictating text which can be sent as an SMS or Email or copied and pasted into another app. The app uses Androids built-in Speech

Recognizer to turn speech into text. The app is also capable turn text into speech. The interface of the application is shown in Figure 2.

**Articulation Essentials 2.0 – LITE:** Articulation Essentials is a fantastic program that makes speech therapy enjoyable and is the greatest method to practice articulation at home without the assistance of a speech pathologist. Speech Therapy for Articulation Apraxia, Aphasia, Phonology, Stuttering, Naming Therapy and Autism is made easier with Articulation Essentials. It includes a large collection of word flashcards that span a wide range of sounds that youngsters frequently have trouble pronouncing. Speech-Language Pathologists (SLPs), parents, and instructors can use it to develop pronunciation.

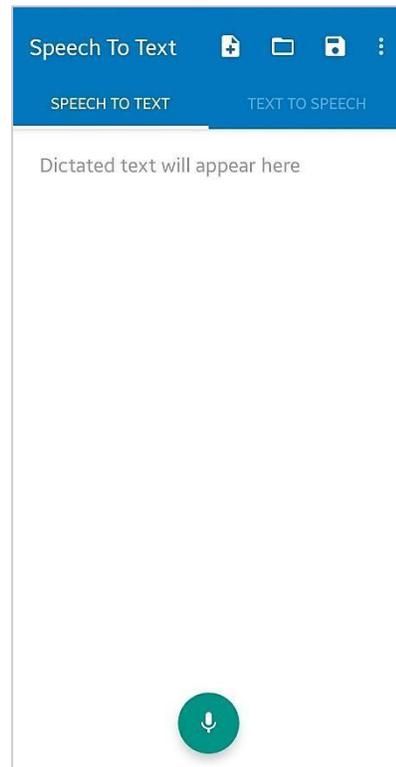


Figure 2 Speech to Text Application

**Apraxia Therapy Lite:** With a revolutionary speech therapy tool that uses video to help individuals talk again, you can take on apraxia and aphasia front-on. Get an app that will help you deal with the frustration and helplessness that comes with not being able to communicate adequately after a stroke. Keep an eye on the mouth movements of the model in the video. Listen carefully, tap your feet in time, and speak in harmony. As the audio goes away, repeat the process, utilizing the video to keep the discourse continuing strong. Speak alone, with only your eyes to guide you. Your words are being recorded automatically. Listen to yourself and assess your performance. To keep your therapy at the correct level, adjust the pace or complexity. Send the

recordings to your speech therapist or a family member through email. The interface is shown in Figure 3.



Figure 3 Apraxia Therapy App

**Speech Therapy:** K is a comprehensive software that teaches you how to pronounce K as well as how to train and cue your kid to pronounce the sound. Then, in the comfort of your own home, we'll show you how to practice K in a methodical way. This app includes all the resources you'll need as well as game suggestions for different levels of practice. You may also pull up an additional section of photo flashcards on your tablet for rapid practice.

**ABA Cards:** Autism Therapy Flashcards ABA Cards is a customizable flashcards software for autistic learning that includes Discrete-Time Trials, Intensive Teaching, and skills testing. In telehealth mode, you may work face to face or conduct remote sessions! ABA Cards is an app that allows you to spend up to 5 hours a week with your pupils instead of producing flashcards and visual materials. It's great for applied behavior analysis (ABA) therapists and other professionals who work with students with autism and similar conditions.

**HelpMe Talk:** HelpMe Talk helps to improve the Speech capabilities of people with speech and language disorders who are receiving Speech Therapy. This program is jampacked with intriguing animation, voices, and useful activities. This motivates practice and leads to improved speech improvement. Through this analysis of different apps, we conclude that the precious work or all these apps are based on simply pronunciation of words or sentences, and only a few of them convert our speech to text or text to speech. All these systems do not convert our faulty speech into the correct one. Therefore, our purpose is to recognize the user's voice and perform rectification using some Natural Language Processing techniques and use language modeling procedure for refinement of user language and as a result return, the user remedied speech after performing an evaluation of outcomes.

Table 1.: Comparison of different parameters of Applications

App	Recognize Voice	Text speech	Rectifies	Pronounces
Speech Therapy	No	Yes	No	Yes
Speech-to text	Yes	Yes	No	No
Articulation Essentials 2.0 – LITE	No	Yes	No	Yes
Apraxia Therapy Lite	No	Yes	No	Yes
Speech Therapy: K	No	Yes	No	No
ABA Cards: Flashcards for Autism Therapy	Yes	Yes	No	No
Help Me Talk	Yes	Yes	No	Yes

Furthermore, a lot of research is done in the recent past for speech articulation problems. [1] based on human auditory processing, created a model for voice analysis. The model was made up of a bank of 40 separate channels that ranged from 130 to 6400 Hz in frequency. A linear critical band filter was used on each channel, followed by a model for the transfer from basilar membrane motion to nerve fiber response, which includes nonlinear phenomena such as halfwave rectification, adaptation, spontaneous response, and saturation. The exact waveform of each cycle of the probabilistic response is included in the output of this step, but the data is never converted to a spike sequence. Finally, each channel was subjected to envelope and synchrony detection separately, with the latter adjusted to the corresponding filter's characteristic frequency [CF]. The envelope reaction was most likely effective for identifying sound boundaries and making broad category selections, but the synchronous response was better for small distinctions. [2] proposed a multitier method for delivering speech treatment to youngsters with apraxia of speech through the Internet. The system, which was built on a client-server architecture, allowed for task-oriented remote therapeutic training in both home and clinic settings. A speech-language pathologist (SLP) might assign speech production activities to each kid remotely via a web interface, and the child may practice them as a game on their mobile device. The child's

words were captured and sent to a back-end server, where a speech-analysis engine scored them automatically. The SLP may then use a web interface to analyze the individual recordings and automated scores, give the kid feedback, and adjust the training program as required. A pilot study involving children with apraxia of speech, their parents, and speech-language pathologists (SLPs) validated the approach. They talked about the system's overall client-server architecture, middleware technologies utilized to construct it, speech-analysis tools for automated utterance scoring, and clinical study findings. Their findings, which were based on mobile technology and automated speech analysis algorithms, confirmed the system's utility as a complement to traditional face-to-face treatment. [3] Researchers created "Tabby Talks," the multi-tier approach for conducting speech treatments electronically. The investigation has included a complete explanation of the voice processing system, that was used to automatically detect frequent CAS problems. Speech signals recognition, pronouncing validation, and vocabulary strain validation were some of the components in the process. To recognize silent portions and determine voice latencies and total production time, the voice activity detectors examine the amplitude profile of a syllable and match it to an iterative method. The pronunciation verification module employed a general search lattice structure with various internal routes that covered all conceivable pronunciation problems in the child's production (substitutions, insertions, and deletions). Finally, the lexical stress verification module used a combination of prosodic and spectral measures to partition lexical stress into strong–weak or weak–strong patterns over subsequent syllables. These mistake data could be sent to therapists through a web browser, ability to make changes to the children's therapy program from a distance. The method achieves a phonetic transcription phonics verification precision of 88.2 % and a word uttered phonics verification precision of 80.7 %, as well as an 83.3 percent linguistic strain classification rate, once evaluated on a set of data of ordinarily creating and troubled talk from kids aged 4–16 years. [4] Patients with dysarthric speech after a neurological disability such as a stroke or Parkinson's disease can benefit from e-learning-based speech therapy (EST). Patients with dysarthria can use EST to enhance traditional face-to-face therapy and to continue speech training after active therapy has stopped. This telerehabilitation tool allowed therapists to create and monitor a personalized speech training program for each patient while also compiling a dysarthric speech database. Patients with dysarthria, a speech disability caused by acquired neurological deficits such as stroke or Parkinson's disease, can benefit from E-learning-based speech therapy (EST), a web program for speech training created in the

Netherlands. [5] The goal of their work was to create and build a speech therapy game application as an extra neurorehabilitation modality for aphasia patients, as well as to evaluate its usefulness as an auxiliary to standard neuromuscular rehabilitation through a pilot study. For eight weeks, seven aphasic patients had eight sessions of game-based speech therapy, each lasting 10–15 minutes and taking place once a week. Aphasia evaluation in stroke patients was done using a multidimensional assessment tool that was included in the therapeutic game and was based on the quick aphasia battery (QAB) results before and after therapy. The QAB subtests of the level of awareness, linked speech, word comprehension, sentence comprehension, picture identifying, repetition, reading aloud, and motor speech all showed improvements when compared before and after therapy.[6] This research presents an app that can help patients with speech problems during their speech treatment sessions. AppVox is a speech trainer that replicates a vocalizer (audio stimulus feature). They wanted to introduce the app as an assistive technology alternative and see if it might be used for digital engagement by youngsters with speech impairments in this article. They provided a case study in which users were requested to complete activities using the AppVox application to evaluate the app. The results revealed that while engaging with the program, this set of participants performed well.

[7] They used a heuristic evaluation to assess the usefulness of a local prototype mobile speech treatment app. The study's findings revealed that the mobile application was well received by both children and their parents and that it aided in the development of the children's ability to produce accurate sounds. [8] They've created the Kimbee app, which promises to make speech therapy more effective for young children. Their application is an addition to speech therapy, not a replacement for it. Therapists can utilize Kimbee to have their pupils work at home and in the classroom, rather than being confined to brief sessions. The therapist may then use our app to track the child's development and adjust the therapy to the student's specific needs. School districts and parents that pay for their child's therapy saved time and money because of this. [9] The purpose of this paper was to highlight an evidence-based strategy to develop a mobile app to increase patient access to speech therapy as a treatment for globus pharyngeus. A search of the literature was carried out to find papers that investigated the use of speech therapy as a treatment option for this illness. A survey of speech and language therapists (SLTs) in the United Kingdom was conducted to evaluate patient access to this treatment and their thoughts on the creation of a mobile app. There were four studies found, one of which was a randomized control trial. Following the use of speech therapy, all of the papers show a considerable improvement

in symptoms. [10] The automated speech therapy system (STS) was created with the primary goal of assisting youngsters in improving their communication abilities. The goal of this article was to look at a variety of voice dysfunction issues as well as studies towards establishing automatic STS.

### III. METHODOLOGY

The methodology is divided into phases; the first phase is to collect/ make the dataset for training and evaluating language model if the accuracy/perplexity of the model is better then to develop and test the application. We have created a dataset consisting of 4087 sentences of English Language and 2364 words for the training language model.

#### A. Development Point of View

Before starting the planning and development of any product, it is important to completely understand and examined whether this product is develop-able or not. Because most of the time, the idea which we choose and we also plan everything about it in our imagination and without any investigation we further start the development phase, then, in the end, we stuck in the middle, why this happens because we don't perform certain observations, do not evaluate our idea and start to proceed it further without any testing. Therefore, a prescribed approach by the terminology of software engineering lies in that if any project or product is testable, then that product or project is also developable. Because testing is related to development, any application which can be tested can be developed also. All the core functionality of the product is clearly verified as above and if we consider the general perception then there is no confusion that comes to our mind. As all the modules and components of the product are testable then in the result, we conclude that it's the developable product.

#### B. Proposed Methodology

Our purpose is to develop a system that will be able to rectify the Articulation Speech Disorder. Because there is no app or software system developed which can help to overcome this speech disorder. We can find research papers on articulation speech disorder and find the people's suggestions that how to diagnose this disorder, but still, there is no implantable system to rectify this disorder. Research mainly focuses on converting the human voice into text or text into speech. But our aim is to develop such a system that can treat this speech disorder, help people to overcome this problem, and live their life as normal human beings. We recognize the user voice by using Google API (speech-totext), afterwards, we will use Natural Language Processing (NLP) technique which includes lemmatization, tokenization, then further we use language modeling technique in which we compare the user speech text with a large set of datasets that help us to

rectify the user disorder speech and basically, that is our main goal behind all these techniques. Essentially, Articulation speech disorder focuses on errors in the production of individual speech sounds. It's signs and symptoms are as follows:

- Articulation Speech Disorder A speech disorder involves difficulties in articulating specific types of sounds. Articulation disorders often involve the substitution of one sound for another, slurring of speech, or indistinct speech. *Signs and symptoms*

*Omissions or deletions:* Omissions or deletions: certain sounds are omitted or deleted (e.g., "cu" for "cup" and "poon" for "spoon")

*Substitutions:* one or more sounds are substituted (e.g., "thing" for "sing" and "wabbit" for "rabbit") *syllable-level errors:* weak syllables are deleted (e.g., "tephone" for "telephone")

The hope is that we will be able to develop a system that will detect the impairments as mentioned above (i.e., signs and symptoms) in the human voice and then return the correct voice by using artificial intelligence and machine learning algorithms. This system will be capable to help people better manage their conditions and live a life that's conducive to healthier vocal behaviors.

The proposed structure of the application is shown in figure 4.

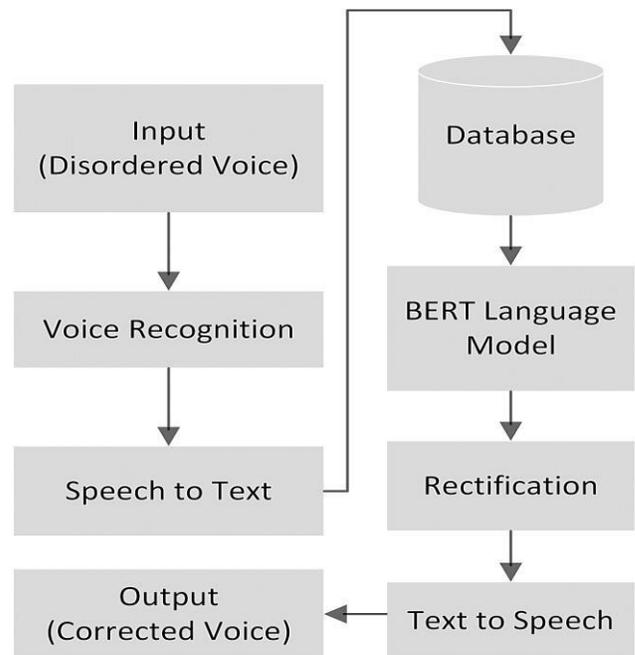


Figure 4. Proposed Methodology

Input: Proposed system will get the speech of the person as input which is to be processed.

Voice Recognition: System will recognize the user’s voice and what he/she is trying to speak.

Speech to Text: Here, the system will convert the user’s voice into text form after recognition of the user’s voice.

Processing: The system will process the text and apply language modeling, then rectifies the text, and then will generate speech from text.

Output: Corrected speech will be generated as output.

*D. System Requirements and Design*

System Requirements: The requirement phase is the most tricky and valuable phase for our system. There are two types of main requirements that exist.

- Functional Requirements
- Non-functional Requirements

Functional Requirements: All the fundamental activities, actions or requirements that are the main actions of our project is described in this section.

- *Authentication:* No user will be able to login into system without an email and password.
- *Sign Up:* User will be able to register through email, name, password and confirm password. So, he/she will be able to input his/her voice.
- *Login:* User will be able to login through email and password. So, he/she will be able to input his/her voice.
  - *Sign Out/ Log Out:* User will be able to log out/sign put from the system.
- *Speech to Text Conversion:*
  - Input user voice/speech.
  - System will recognize user speech.
  - System will apply BERT model on user voice.
  - System will convert user speech to text after speech recognition.
  - System will convert user speech to rectified speech after speech rectification.
- *Text to Speech:* User will enter text for practice. System will convert user’s text to speech.
- *Add to Database:* User can enter some correct and incorrect words to dataset which he feels that are not corrected by the system.
- *Speech Therapy:* User can practice the pronunciation of words so he can pronounce the correctly.
- *Speech Therapist:* User can find speech therapist through our system.

*Table 2 Functional Requirements of proposed Application*

Requirement No.	Functional Requirement Details
1	Authentication (Successful Signup, Login and Logout)
2	Speech to Speech
2.1	Input user voice/speech. System will recognize user speech. System will apply BERT model on user voice. System will convert user speech to text after speech recognition. System will convert user speech to rectified speech after speech rectification.
3	Text to Speech
3.1	User will enter text for practice.
3.2	System will convert user’s text to speech.
4	Add to Database
4.1	User can enter some correct and incorrect words to dataset which he feels that are not corrected by the system.
5	Sound Therapy
5.1	User can practice the pronunciation of words so he can pronounce the correctly.
6	Speech Therapist
6.1	User can find speech therapist through our system.

Non-Functional Requirements: Non-functional requirements that are used to evaluate the operation of the system rather than specific behavior.

IV. RESULTS AND DISCUSSION

**First Screen**

This is the screen that when user opens the app:



Figure 5. Welcome Interface of developed App.

### Dashboard Screen Interface

A screen for login will appear and user will login through username and password. If user successfully attempts login a dashboard screen will appear as below:



Figure 6. Dashboard

### Speech to Speech Screen Interface

From the dashboard menu user will be able to navigate the functions like Speech to Speech, Speech Therapy, Text to Speech, Add to Data set and Speech Therapist. Figure 4 is the Speech-to-Speech interface for a use.



Figure 7. Speech to Speech Menu

### V. CONCLUSION

This project aids those who have difficulty articulating their words and gives real-time assistance, wherever and at any time. Using the BERT by GOOGLE advanced search algorithm for next word prediction, the research was able to fully leverage artificial intelligence. We became able to create a project by training the BERT algorithm using Python and producing our own dataset to train BERT with the help of certain language modelling techniques and laboring Natural Language Processing algorithms. This initiative benefits people and will encourage other researchers to become interested in it and work to increase its efficiency and accuracy through research and development

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